iv. Experimental Vacuum Systems

Each experimental area is defined by the space between the beam pipe end flanges of the two DX magnets and is 17.23 m in length. Each area, as shown in Fig. 4-6, is subtended by all-metal, rf-shielded gate valves, beam position monitors, bellows, sputter ion pumps and titanium sublimation pumps. The space available for the experimental beam pipes (EBPs) and detectors is approximately 14.2 m in length.

The beam pipes adjacent to the sputter ion pumps will be RHIC standard 12.7 cm warm bore tubes with a diameter transition down to 7.6 cm, followed by 7 cm ID rf-shielded bellows. To maximize the transparency for the experiments, the 1.5 m central sections of the EBPs for three experiments, STAR, PHENIX and BRAHMS, will be made of beryllium (Be). The EBP of PHOBOS will consist of three 4-m Be sections joined together with Be flanges, bolts and nuts. The OD of the Be sections will be 7.6 cm and the nominal wall thickness 1 mm. The 7.4 cm ID of the EBP will be sufficient to provide the required 10ó beam aperture (up to ± 5 m from IP) for all the RHIC operating

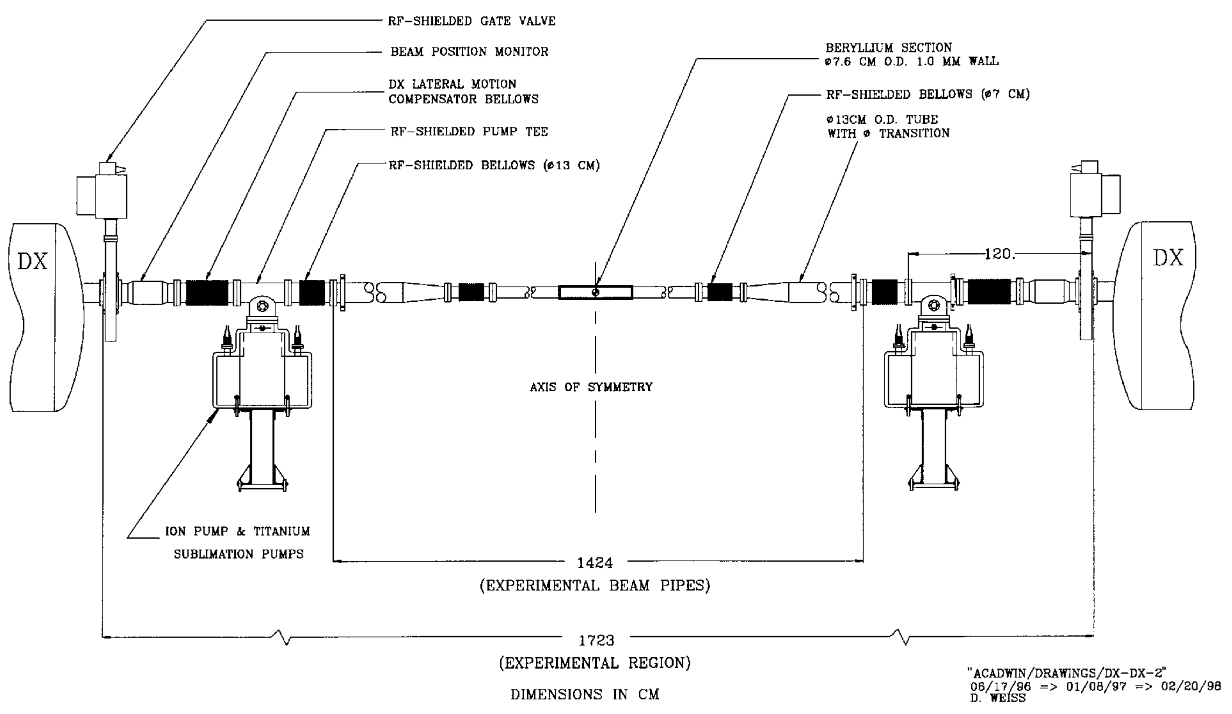

Fig. 4-6. Layout of the vacuum components at experimental regions.

Table 4-1. Experimental Beam Pipes

Experiment	EDP Length	Be Section	Extension	Flange
STAR	8 m	1.5 m	A1	A1 Conflat
PHENIX	5.2 m	1.5 m	Stainless	SS Conflat
PHOBOS	12 m	3 × 4 m	None	Be Conflat
BRAHMS	7.1 m	1.5 m	A1	A1 Conflat

conditions. The Be section is either to be extruded from a billet or to be fabricated from Be sheet rolled into a tube with a longitudinal braze joint. The Be sections are brazed to stainless steel or aluminum extensions and then welded to the 11.8 cm conflat flanges to form the complete EBPs. The table below lists the length of the EBP, the length of the Be sections and the type of extensions and flanges for each experiment.

To achieve the designed vacuum of mid 10^{-10} Torr, the entire interaction region (from gate valve to gate valve) will be in-situ baked to 250°C (150°C for EBPs with aluminum extensions). In-situ bake will be accomplished with custom heating blankets fitted around the EBPs and other vacuum components. Heated dry nitrogen flow may be used to bake the central section of the EBPs where installation and removal of the heating blankets is not practical. The in-situ bake will be monitored and controlled with industrial temperature controllers. The bake will be completed in a week, including the time for set up and removal of bakeout equipment and the ramp and soak periods.

The average pressure inside the EBPs after in-situ bake can be approximated by:

$$P_{\text{avg}} = \pi D q \left(\frac{L}{S} + \frac{L^2}{3C} \right)$$

with D the diameter of the EBP, q the unit outgassing rate, $2S$ the pumping speed (i.e., $S = 500$ ℓ/s), $2L$ the distance between the pumps ($L = 775$ cm) and C the linear conductance (~ 2×10^4 ℓ cm/sec for H_2 and ~ 5×10^3 ℓ cm/sec for CO). The outgassing rate of the EBPs will be at low 10^{-12} Torr·ℓ /sec·cm^2 after the in-situ bake and the average pressure of mid 10^{-10} Torr will be achieved.